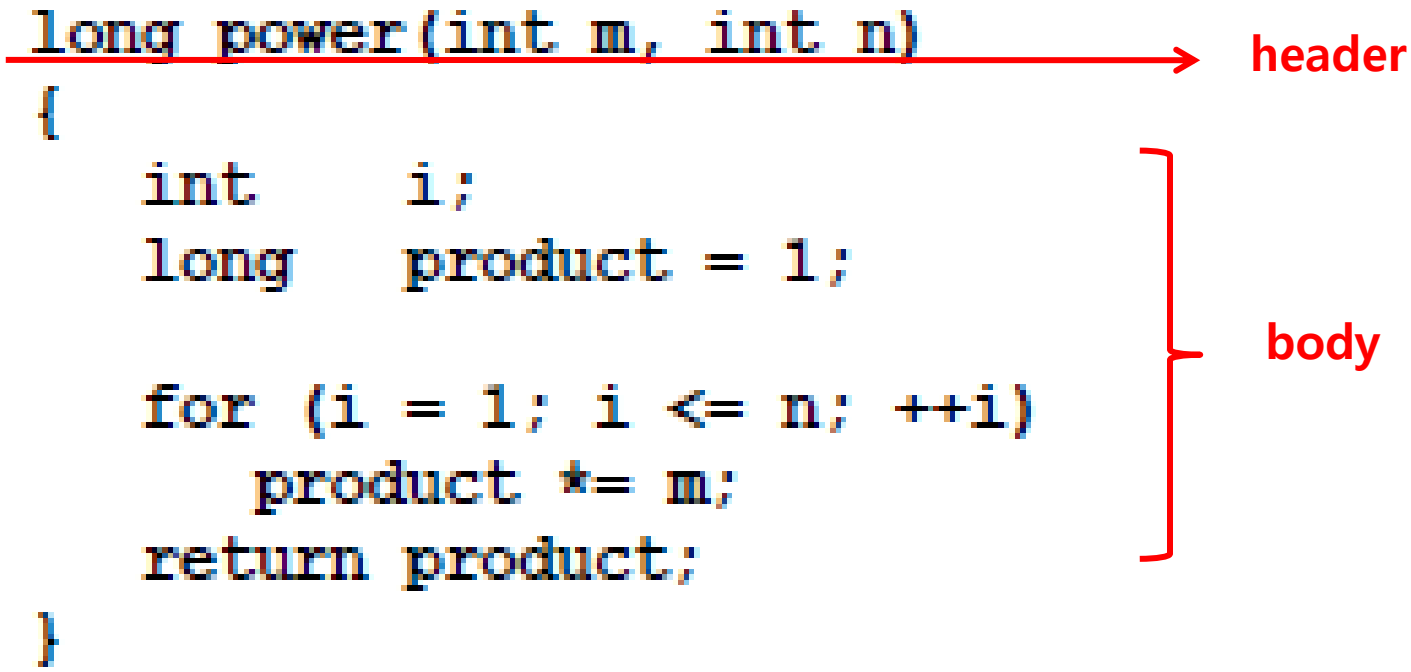
Functions

Flow of Control Review

- while
- for
- do while
- goto
- break & continue
- switch
- Relational operators
- short circuits

Functions

- To avoid repetitive similar code
- To structure the whole program as “top-down” approach
  - Breaking up a large problem into smaller pieces and break each piece into smaller ones until each piece is readily expressed in code
  - Each piece should be concise and logical entity


long power(int m, int n)
{
int i;
long product = 1;
for (i = 1; i <= n; ++i)
product *= m;
return product;
}
header
body

Function Definition

- function type
  - Type of the return value, if any
  - If missing, it is assumed to be int
- parameters are placeholders for values that are passed to the function when it is invoked
- return statements

```
return;
return a+b;
return (a+b);
```

Function Prototypes

- Each function should be declared before it is used
  - what if your program structure is top down?
  - some people prefer bottom-up approaches
- Usually, they are placed before the main( ) function
- Parameter names can be omitted (ANSI C)
  - parameters can be omitted (old C)

```
void f(char c, int i);
void f(char, int);
```

```
#include <stdio.h>

#define   N   7

long   power(int, int);
void   prn_heading(void);
void   prn_tbl_of_powers(int);

int main(void)
{
   prn_heading();
   prn_tbl_of_powers(N);
   return 0;
}

void prn_heading(void)
{
   printf("₩n:::::  A TABLE OF
POWERS  :::::₩n₩n");
}
```

```
void prn_tbl_of_powers(int n)
{
   int   i, j;

   for (i = 1; i <= n; ++i) {
      for (j = 1; j <= n; ++j)
         if (j == 1)
            printf("%ld", power(i, j));
         else
            printf("%9ld", power(i, j));
      putchar('₩n');
   }
}

long power(int m, int n)
{
   int    i;
   long   product = 1;

   for (i = 1; i <= n; ++i)
      product *= m;
   return product;
}
```

Function Invocation

- The program starts by invoking the main function

- parameters are passed as call-by-value
  - you can implement call-by-reference with pointers

```c
#include <stdio.h>

int main(void)
{
   int    n = 3, sum, compute_sum(int);

   printf("%d₩n", n);          /* 3 is printed */
   sum = compute_sum(n);
   printf("%d₩n", n);          /* 3 is printed */
   printf("%d₩n", sum);        /* 6 is printed */
   return 0;
}

int compute_sum(int n)         /* sum the integers from 1 to n */
{
   int    sum = 0;

   for ( ; n > 0; --n)         /* stored value of n is changed */
      sum += n;
   return sum;
}
```

Developing a Large Program

- Usually developed by several teams
- Comprises many .h and .c files
  - each .c file can be compiled separately
- gcc –o pgm main.c fct.c wrt.c

pgm.zip

```
pgm.h
#include ...
#define ...
...
templates of enum.,structure,union types
list of function prototypes
```

```
main.c
#include "pgm.h"
...
```

```
fct.c
#include "pgm.h"
...
```

```
wrt.c
#include "pgm.h"
...
```

Assertion

- you can make sure a certain condition holds true at any place of program
  - it is a macro defined in the header file assert.h
  - assert(expression);
  - if the value of the expression is zero abort the program

Scope Rules

- identifiers are accessible only within the block where they are defined
  - they are invisible from outside

```
{
 int  a = 2;
 printf("%d\n", a);
 {
  int  a = 5;
  printf("%d\n", a);
 }
 printf("%d\n", ++a);
}
```

Storage Classes

- Every variable and functions in C has two arrributes: type and storage class

- Storage Classes

  auto extern register static

auto

- the most common class
  - variables defined inside a function
  - variables defined outside a function are global
- default class – you may omit it

- the memory space is allocated/released when the function is invoked/exited

- when a function is reentered, the previous values are unknown

external

- global
- they may be defined somewhere else (in another file)
- they never disappear
  - transmit values across functions
- they may be hidden by re-declaration, but they are not destroyed

```c
#include <stdio.h>

int   a = 1, b = 2, c = 3;
int   f(void);

int main(void)
{
   printf("%3d\n", f());
   printf("%3d%3d%3d\n", a, b, c);
   return 0;
}

int f(void)
{
   int   b, c;

   a = b = c = 4;
   return (a + b + c);
}
```

main.c

```
#include <stdio.h>

int   a = 1, b = 2, c = 3;      /* external variables */
int   f(void);

int main(void)
{
   printf("%3d₩n", f( ) );
   printf("%3d%3d%3d₩n", a, b, c);
   return 0;
}
```

fct.c

```
int f(void)
{
   extern int   a;              /* look for it elsewhere */
   int          b, c;

   a = b = c = 4;
   return (a + b + c);
}
```

```
CC      =  gcc
CFLAGS  =  -Wall
EXEC    =  a.out
INCLS   =
LIBS    =

OBJS    =  main.o  fct.o

$(EXEC): $(OBJS)
        @echo "linking ..."
        @$(CC)  $(CFLAGS)  -o $(EXEC)  $(OBJS)  $(LIBS)

$(OBJS):
        $(CC)  $(CFLAGS)  $(INCLS)  -c  $*.c

relink:
        @echo "relinking ..."
        @$(CC)  $(CFLAGS)  -o $(EXEC)  $(OBJS)  $(LIBS)
```

register

- allocate this variable on a register
- to speed up the execution
- not always possible to find a register
- tricky for memory-IO operations

static

- to preserve the value even after the function exits
  - extern does the same
- to control visibility of variable and functions
  - "static extern" - visible only within the same source file

```
void f(void)
{
   static int cnt = 0;

   ++cnt;
   if (cnt %2 == 0)
            .....
   else
            ....
}
```

```
static int seed = 100;
/* static extern – external, but invisible from other files */

int random(void)
{
   seed = 25173 * seed + 13849;
            ....
}
```

```
/* function g( ) can be seen only within this file */
static int g(void)
{

        ....
}



void f(int a)
{
        .....
        ....
}
```